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**PACKAGING PERFORMANCE TESTING**  
**OF A**  
**CORRUGATED FIBERBOARD BOX (14 IN. BY 14 IN. BY 18 IN.),**  
**CONTAINING FOUR 1-QT RECTANGULAR PLASTIC BOTTLES FOR USE WITH**  
**LIQUIDS – PACKING GROUP I (SURFACE MODES)**

Date: August 8, 2001

AFPTEF PROJECT NUMBER: 01-101  
POP TEST ID NUMBER: DODPOPHM/USA/DOD/AF69/DLA-F015



**Part 1. Report Cover**

TEST REPORT APPLICABILITY STATEMENTS see section 2E:

Manhours: 20

Report Prepared by: \_\_\_\_\_

Susan J. Evans  
Materials Engineer

**A. Report Number:** DODPOPHM/AF69/DLA-F015

**B. Title:**

CORRUGATED FIBERBOARD BOX (14 IN. BY 14 IN. BY 18 IN.), CONTAINING FOUR 1-QT ROUND PLASTIC BOTTLES FOR USE WITH LIQUIDS - PACKING GROUP I (SURFACE and AIR MODES)

**Responsible Individual:** Michael Werneke

This report has been approved for publication and dated:

Approved by:

\_\_\_\_\_  
L.A. WOOD, Chief  
Engineering Branch

\_\_\_\_\_  
MICHAEL WERNEKE  
Chief, AF Packaging Technology and Engineering Facility

**Performing Activity:**

AF Packaging Technology and Engineering Facility  
AFMC LSO/LOP  
5215 Thurlow St  
WPAFB OH 45433-5540

**AFPTEF Reference:** 01-101

**Date:** August 7, 2001

**Report Type:** Final

**Specific Authority:**

Distribution Statement F. Further dissemination only  
as directed by the Air Force Packaging Technology and  
Engineering Facility (AFPTEF), AFMC LSO/LOP,  
5215 Thurlow St, WPAFB OH 45433  
or higher DoD authority.

Requesting Organization: Defense Logistics Agency  
DDC-J-3/J-4-0  
ATTN: Linda McCarthy  
2001 Mission Drive  
New Cumberland PA 17070

Requesting Organization's Reference(s):

(1) Letter 6 Dec 2000

**Part 2. Data Sheet****A. Exterior Shipping Container****UN Type:** FIBERBOARD BOX**UN Code:** 4G**NSN:** 8115-00-417-9320**Specification Number(s):** ASTM D5118, Style RSC./ASTM D4727, Type CF, Class WR, VAR SW, GR 350, V3c**Container Manufacturer:** Lynchburg Sheltered Industries, Lynchburg, VA 24501**Date of Manufacture:** 2001 (GSA advice code "2G" – newest stock)**Material:** Corrugated Fiberboard**Container Dimensions:** 14 in. x 14 in. x 18 in. ID**Closure (Type/Method):** ASTM D1974, Sealing Method B (7-Strip Method). Use 2-inch A-A- 1830 clear tape on closure, NSN 7510-00-266-6715.**Reinforcement (Type/Method):** ASTM D1972, Reinforcement Method 2B, using 1-inch wide filament reinforced tape (1 girthwise band for every 15 inches of box height/length).**Closure Specification Number(s):** A-A-1830 clear tape, 2-inch, NSN 7510-00-266-6715.**Reinforcement Specification Number(s):** A-A-1687 Fiber reinforced tape, 1-inch; NSN 7510-00-582-4772.**Absorbent Material Description:** Vermiculite, Fine Grain, Palmetto Vermiculite Company, Incorporated, Grade C-3; Hazmatpac A-900, HAZMATPAC Inc.; and Absorbent GP, Absorption Corporation.**Additional Description:** N/R**B. Inner Packaging of Combination Packaging****Type:** Rectangular plastic bottle, with handle.**Manufacturer/Distributor:** Consolidated Plastics, Inc., Twinsburg OH**Date of Manufacture:** N/R**Manufacturer's Number(s):** 41992LG**Capacity:** 1 quart**Dimensions:** 5.0 in. x 2.0 in. x 7.5 in.**Closure (Method/Type):** Screw cap (plastic).**Secondary Closure (Method/Type):** One strip of reinforced tape (as above) wrapped a minimum of 1 ½ times around and overlapping the cap(s) base and the bottle neck(s).**Additional Description:** N/A**C. Actual Product: Not Used****D. Test Product: Used****Name:** 50% water/propylene glycol mixture**United Nations Packaging Group:** I**Physical State:** Liquid**Amount per outer container:** 4 (quarts)**Test Weight (packaged with vermiculite):** 32 lb (14.5 Kg) See Part 3.**Test Weight (packaged with A-900):** 45 lb (20.4 Kg) See Part 3.**Test Weight (packaged with Absorbent GP):** 13.2 lb (13.2 Kg) See Part 3.**Density/Specific Gravity:** 1.0**Drop Height:** 1.8 meters**Stacking Weight/Force Required:** 250 lb (113.4 Kg)**Stacking Weight/Force Used:** 306 lb (138.8 Kg)**Additional Description:**

1. Line the box with a 4-mil polyethylene gusseted bag, size 16 in. x 14 in. x 36 in.
2. Place 5 inches of absorbent in bottom of box. [If using HAZMATPAC A-900 or Absorbent GP, firmly compress the bottom layer and add absorbent to a depth of 5 inches.] Place 4 bottles on absorbent layer in pinwheel pattern (see pictures). Separate the bottles from one another and from sides of box by at least one inch. If using Absorbent GP or A-900, firmly compress approximately every 2 inches and add material until bottle tops are reached. Cover with a minimum of 5 inches of absorbent. **NOTE: The amount of absorbent**

**used in this combination packaging configuration does meet the requirements of AFJMAN 24-204, Atch 20, for Packing Group I liquids, in 1-quart quantities.**

3. Shake down and firmly compress, and add absorbent to make a tight pack.
4. Twist bag and tape closed with fiber reinforced tape.
5. Closure IAW 2a.

**E. Test Applicability-** See test results in parts 7

- (1) Tests documented herein are design qualification. It is the responsibility of the government shipper/certifier to fully verify design compliance and packaging material quality.
- (2) Drop testing performed herein was tested in accordance with DLAD 4145.41, AR 700-143, AFJI 24-210, NAVSUPINST 4030.55A, and MCO 4030.40A. This joint DoD policy document allows packaging to be drop tested more than once provided the packaging continues to pass the 49CFR 178.603 requirements. Questions about or clarification of this policy can be sought from the respective preparing activities of the regulation.
- (3) DoD contractor use of this test report or its resultant certifying mark only with the permission of the testing activity AND as specified in DLAD 4145.41, AR 700-143, AFJI 24-210, NAVSUPINST 4030.55A, and MCO 4030.40A.
- (4) Pass/fail conclusions were based on the particular specimens, both inner and outer containers, and quantities of each submitted for test. Extrapolation to other manufacturers, applications, commodities, inner containers, container sizes, or lesser internal quantities is the responsibility of the packaging design agency or applicable higher headquarters and the limitations documented in 49CFR. Extrapolation of test results based on lesser than minimum UN/DOT required test specimens is also the responsibility of the packaging design agency or applicable higher headquarters.
- (5) Reference to specification materials has been made based on one of the following methods: supplied by AFPTEF, provided by the requester, markings printed on, attached to or embossed on the packaging.
- (6) Testing performed in accordance with 49CFR 170-180, except as documented in this report.
- (7) Performance testing was undertaken and completed at the request of an agency responsible for management of the dangerous good(s). The completion of successful UN/DOT testing does not, by itself, authorize the marking and transportation of the dangerous good(s). Applicable modal regulations should be consulted concerning the relationship of performance testing completed and the dangerous good(s).
- (8) The DOT performance tests are intended to evaluate the performance of the entire packaging configuration's ability to prevent the release of contents during conditions normally incident to transportation. The criteria used to evaluate container system performance is whether the contents of the packaging are retained intact. The successful completion of the recommended tests does not ensure undamaged delivery.
- (9) Tests performed and documented, herein, in no way verify Government supplier's operations (included but not limited to: internal procedures, suppliers, or manufacturing processes) comply with the DOT's or international's regulations. The testing facility has no knowledge and assumes no knowledge, that specific material testing requirements (i.e. plastics - only allowed to use regrind from the same operation; specific vendor plastic formulations including quantity of carbon black, ultra-violet inhibitors or pigments, or production run's individual leakproofness tests) are or were performed by the manufacturer(s) listed herein, unless otherwise noted in the report.

**Part 3 Introduction.**

**Brief description of why specific tests were performed and rationale for the test product selected (if applicable).**

The equivalent of Packing Group I testing, surface modes, was requested on the above stated configuration. This configuration is intended to be applicable to a large assortment of liquid products contained in plastic bottles. For lesser volumes, variations to testing requirements can be found in 49 CFR, part 178.601(g).

**Three packaging configurations were actually tested, differing only in the absorbent/cushioning material: vermiculite, HAZMATPAC A-900 and Absorbent GP.**

**NOTE: The amount of absorbent used in this combination packaging configuration does meet the requirements of AFJMAN 24-204, Atch 20, for Packing Group I liquids, in 1-quart quantities.**

A 50% water/propylene glycol mixture was used as the test liquid as permitted by 49 CFR part 178.602(c).

Each combination packaging was subjected to appropriate drop and vibration testing as prescribed by ASTM D4919. These tests are designed to simulate the shock and vibration a package configuration may encounter during conditions normally incident to transportation. The order of testing was drop test followed by the vibration test; the stacking test was performed on empty outer containers. The Cobb test was performed on samples taken from boxes not otherwise used in testing.

*The use of one sample packaging configuration for multiple tests and drops is DoD policy as stated in DLAD 4145.41, AR 700-143, AFJI 24-210, NAVSUPINST 4030.55A, and MCO 4030.40A. This option was exercised in this test as noted in Part 7.*

#### **Part 4. Tests Required/Performed:**

**NOTE:** Packagings fabricated from fiberboard, paperboard, or paper, including composite containers with outer fiberboard containers, should be conditioned for a minimum 24 hours prior to testing. Standard conditions  $23 \pm 3^{\circ}\text{C}$  ( $73 \pm 4^{\circ}\text{F}$ ) and  $50 \pm 2\%$  relative humidity apply.

**A. Hydrostatic Pressure Test** - 3 outer containers each individually tested for 5 minutes at 15 psig.

**B. Stacking test** - One test per outer container, 3 containers required. Compression by a top load is calculated to simulate a stack height of **3 meters**, maintained for 24 hours. **NOTE:** Where the contents of the test sample are non-dangerous liquids with relative density different from that of the liquid to be transported, the force shall be calculated in relation to the latter.

Static weight. Apply the calculated weights using a constant load evenly over the entire container.

$$M = \frac{m(3000-h)}{h}$$

where: m = container's gross mass (as shipped) in kilograms = 20.4 Kg

h = container's height in millimeters = 457.2 mm (effective height for container in stack)

M = constant load mass in kilograms = 138.8 Kg

or: 
$$W = \frac{w(118-h)}{h}$$

where: w = container's gross weight (as shipped) in pounds = **45 lb**

h = container's height in inches = **18.0 in.** (effective height for container in stack)

W = constant load weight in pounds = **306 lb**

Information - This test assumes similar weight containers stacked on top of the test sample. This may or may not be a valid assumption. This calculation also only provides a minimum weight. Consideration should be given to what will actually be experienced in the transportation cycle.

**C. Drop test** - 5 drops in order: flat on the top, bottom, long side, short side and top corner. The drop height shall be appropriate for the packaging group of the commodity. The container shall strike a target which shall be a rigid, non-resilient, flat, and horizontal surface. For other than flat drops, the center of gravity shall be vertically over the point of impact. The combination packaging and its contents must be at 0°F (-18°C) for testing.

1. Solids and liquids, if the test is performed with the actual contents to be carried, or with another substance having essentially the same characteristics, or for liquids if the test is performed with water and the intended contents has density less than 1.2 g/cm<sup>3</sup> (specific gravity less than 1.2) the drop height shall be:

<u>Packing Group</u>	<u>Drop Height</u>
<b>I</b>	<b>1.8m</b> (70.9 in.)
<b>II</b>	<b>1.2m</b> (47.2 in.)
<b>III</b>	<b>0.8m</b> (31.5 in.)

2. Where the test sample doesn't contain the intended contents and its specific gravity is greater than 1.2, then obtain the required drop height in meters by calculating the following with product density (d):

<u>Packing Group</u>	<u>Drop Height</u>
<b>I</b>	<b>(d) x 1.5m</b> ((d) x 59.1 in.)
<b>II</b>	<b>(d) x 1.0m</b> ((d) x 39.4 in.)
<b>III</b>	<b>(d) x 0.67m</b> ((d) x 26.4 in.)

Round the drop height up to the first decimal.

**D. Vibration Test (Domestic requirement).** One test per container, total of three test specimens.

The test shall be performed for 1 hour at a frequency that causes the package to be raised from the vibrating platform to such a degree that a piece of material approximately **0.2 cm** (1/16 in.) thickness can be passed between the bottom of the package and the platform. The vibrating platform shall have a vertical double-amplitude (peak-to-peak) displacement of **2.54 cm** (1 in.). Perform tests in accordance to 49 CFR 173 Subpart B, Appendix C and 49 CFR 178.

**NOTE: If only one configuration sample is tested, test duration shall be 3 hours.**

## **MATERIAL SPECIFIC TEST**

**E. Fiberboard (Water resistance test)** - One test per fiberboard specimen, total of six.

Strong, solid or double faced corrugated fiberboard (single or multi-walled) must be used, appropriate for the capacity and the intended use of the box. The water resistant outer surface must not increase in mass greater than **155 grams per meter<sup>2</sup> (0.0316 pounds per foot<sup>2</sup>)** after 30 minutes in accordance with International Standards Organization (ISO) 535 or Technical Association of the Pulp and Paper Industry (TAPPI) T441 or ASTM D3285. Three individual fiberboard specimens shall be exposed on the wire side and another three on the felt side.

## **Part 5. Criteria for Passing Tests:**

**A. Hydrostatic Pressure Test** - Any leakage is cause for rejection.

### **B. Stacking test.**

No test sample shall leak. Composite and combination containers shall not exhibit leakage of the filling substance from the inner receptacle or container. No test sample shall show deterioration which adversely affects transportation safety or show any distortion liable to reduce its strength, cause stacking instability, or cause damage to internal container components likely to reduce transportation safety.

### **C. Drop test.**

Each packaging containing liquids shall be leakproof when internal and external pressures are equalized.

Composite and combination containers shall not exhibit damage to the outer packaging likely to adversely affect transportation. In addition, the inner packaging shall not leak into the filling substance or lading. Plastic containers and the contents of combination packagings containing inner plastic containers, must be reduced to 0°F (-18°C) prior to testing.

**D. Vibration test.**

No rupture or leakage from any of the packages. No test specimen shall show any deterioration which could adversely affect transportation safety, result in possible discharge of contents or reduce packaging strength.

**E. Fiberboard (water resistance test).**

The calculated water absorption of all samples shall be less than **155 g/m<sup>2</sup>**.

**Part 6. Discussion and Test results:**

**Narrative description of test results, including any rationale for variations.**

**A. Drop test. Pass**

Tested at standard conditions: 23 Degrees C., 50% RH. The combination packaging and its contents were reduced to 0°F (-18°C) prior to testing.

Each combination packaging, with vermiculite absorbent, was dropped 1.8 meters onto the required four flat sides and a top corner. Except for minor crushing of the impacted areas, no adverse results to the outer packagings were noted; there was no damage to, or leakage from, the interior bottles.

**B. Stacking test. Pass**

Duration: 24 hours at standard conditions: 23 Degrees C., 50% RH.

Three empty, closed outer containers were stacked with 306 lb for 72 hours (extra weight was used to account for potentially heavier configurations). There was no damage to the boxes which could result in damage to the inner containers, no crushing, nor stack instability. No other adverse results were noted.

**C. Vibration test. Pass**

Duration: 3 hours at standard conditions: 23 Degrees C., 50% RH.

The same combination package used in the drop tests was also used for the vibration test. One combination packaging was tested on an electro-hydraulic vibration table which was set at 1-inch vertical double amplitude (peak-to-peak) displacement, at a frequency such that the packaging was raised from the platform. The distance was measured using a 1/16-inch feeler gage. At the proper frequency the feeler gage could be passed between the bottom of the package and the table surface. There was no additional damage to the box or inner container(s) and no leakage from the inner container(s). No adverse results were noted. This test procedure duration of 3 hours with one container exceeds the 49 CFR requirements.

**D. Water resistance (Cobb method) test. Pass**

Test at standard conditions: 23 Degrees C., 50% RH.

As required by 49 CFR part 178.516, the COBB Method Test for water absorptiveness was performed on specimens cut from the lot of boxes used in the drop stack and vibration tests.

3 Specimens were tested on the exterior side. Average **146 g/m<sup>2</sup>**.

Values : **148 g/m<sup>2</sup>, 146 g/m<sup>2</sup>, 144 g/m<sup>2</sup>**

3 Specimens were tested on the interior side. Average **151 g/m<sup>2</sup>**.

Values : **153 g/m<sup>2</sup>, 149 g/m<sup>2</sup>, 150 g/m<sup>2</sup>**



**0 Specimens exceeded the 155 grams per square meter maximum limit.**

Many factors may affect water absorption by corrugated fiberboard. Among these factors are abrasion, wear, flexure, improper storage, and age. These can greatly decrease the ability of the fiberboard to resist water absorption and result in higher than tested results. In addition, some fiberboard products are only treated on one side of the material, making the box construction method of increased importance. Usually, the water resistant side is the smooth side. The shipper must take appropriate steps to ensure that the box is correctly constructed with the water resistant side on the outside.

*For container to pass all applicable tests must be performed and pass criteria listed herein.*

**Part 7. Marking on Container:**

The container specified herein passes the DoT and international regulatory requirements to the extent tested. Equivalent DoD built or grandfathered containers MAY also qualify for the following marking as directed by DoD policy documents.

UN        4G/X20.4/S/01  
            USA/DOD

**Part 8. References**

- A. 49CFR 170-180
- B. DLAD 4145.41/AR 700-143/AFJI 24-210/NAVSUPINST 4030.55A/MCO 4030.40A - Packaging of Hazardous Materials
- C. ISO 535/TAPPI T 441/ASTM 3285 - Determination of Water Absorption of Paper and Board (Cobb Method)
- D. ISO 3574 - Cold-reduced carbon steel sheet of commercial and drawing quantities.
- E. ASTM D999 - Methods for Vibration Testing of Shipping Containers.

**Part 9. Distribution List**

Commander  
Defense Logistics Agency  
DDC-J-3/J-4-0  
ATTN: Linda McCarthy  
2001 Mission Drive  
New Cumberland PA 17070

AFMC LSO/LOP  
Project Folder



Four 1-quart rectangular plastic bottles placed inside a 14 in. x 14 in. x 18 in. fiberboard box, with Absorbent GP, as a combination package.



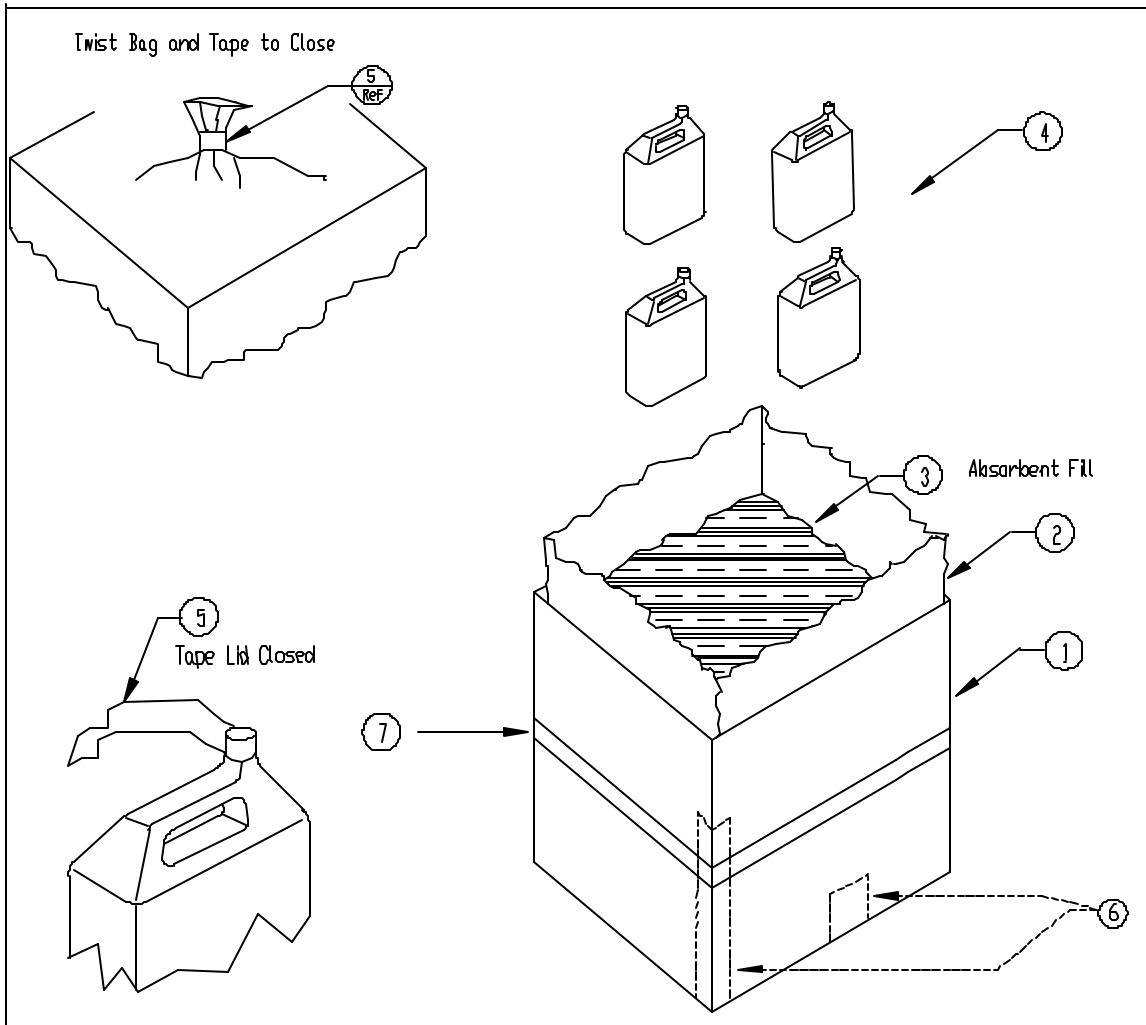
Four 1-quart rectangular plastic bottles placed inside a 14 in. x 14 in. x 18 in. fiberboard box, with HAZMATPAC A-900, as a combination package.



Four 1-quart rectangular plastic bottles placed inside a 14 in. x 14 in. x 18 in. fiberboard box, with vermiculite, as a combination package.



Closed inner liner of combination package containing 4 plastic bottles. Outer container is reinforced with one girthwise strip of fiber reinforced tape.



8			
7	A/R	Girthwise Band, Fiber Reinforced Tape	
6	A/R	Sealing Tape	
5	A/R	Fiber Reinforced Tape	
4	4	Inner Containers, 1-Quart Rect. Plastic w/ Handle	
3	A/R	Absorbent Fill	
2	1	Poly Bag	
1	1	Single Wall Corrugated Fiberboard Box	
Item	Rty	Description	Notes
		<b>AFPTF</b> Air Force Packaging Technology and Engineering Facility	Note: Follow All Instructions in TR
File: DLAFO1501.DWG			Dimensions in Inches
Dwg No: DLAFO15D			Scale: NONE
Engineer: SJ Evans		DATE: 6 August 01	PAGE 1 OF 1